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## COMMUNICATIONS

### FURTHER EXPERIMENTAL STUDIES IN INTRAOCULAR PRESSURE AND TONOMETRY*

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MANY and varied are the lines of investigation and experiment which may be carried out in relation to intraocular pressure, but inasmuch as I have come over here from the States on the invitation of the Master and Council of this Congress, to speak on the subject of tonometry and the McLean tonometer, I will confine my remarks to investigations made along those lines.

My first records of intraocular pressure were made from the finger palpation methods, and I have had no experience with the earlier tonometers such as the Fick, Maklakof, Priestley Smith, Donders, and the others. My first experience with tonometers was with the Schiötz and the Gradle-Schiötz instruments, and in using these instruments I discovered certain annoyances, which it seemed to me could be abolished in a tonometer constructed along different lines.

1. The distance between the cornea of the eye under examination and the reading scale of the Schiötz or Gradle instruments

*Read at the Oxford Ophthalmological Congress on July 10, 1919.

renders it difficult for one person to see that the tonometer is placed correctly on the cornea, and make a reading of the scale simultaneously.

2. A translation of the obtained readings into millimeters on the chart according to the weight used is necessary and consumes time.

3. The delineation of the fine lines on the chart is very trying to the eyes.

4. There are times when the estimated pressure is so far divergent from the indication by the instrument that a delay occurs in changing weights, after the reading has been started. (Some nervous patients while in the recumbent position become annoyed by the delay caused in changing weights, when it has been ascertained that the estimated weight was inadequate for the pressure of the eye under examination.) In this respect the Gradle instrument is an improvement on the Schiötz, as with the Gradle the changing of weights is simplified.

5. I have observed in both these instruments that the plunger fits the footplate barrel so closely that fluid remaining on the cornea at the time of making a reading may be drawn up into the instrument by capillary attraction, and the accuracy of the reading impaired. (Paul Knapp of Switzerland observed the same possibility of error due to capillary attraction).

In my tonometer the calibrations on the scale are in millimeters of Hg. as determined by actual manometer readings; a detailed description of this testing apparatus was given in a former paper.

The scale is placed just above the finger piece and as close to the examined eye as possible, so that it can be more readily observed by the operator.

The plunger, instead of fitting accurately, has a space of one millimeter between it and the base, and is held in position by the rounded ends of three hardened steel bearings placed 120° from each other. This reduces friction to a minimum, and also prevents capillary attraction of any fluid which might remain on the cornea.

All the readings on the scale from 10 to 130 mm. Hg. are made without change of weights.

Before the days of the Schiötz tonometer, I had been estimating the intraocular pressure of patients by the prevailing method of finger palpation. Estimations of pressure, if we translated them into mm. of Hg., were based on the experiment of Wahlfors. His determination of normal intraocular pressure was 26 mm. Hg., which was in harmony with the experiments on the lower animals, made by many other experimenters. This is the only experiment on record in which an eye of normal tension has been connected directly to a manometer.

When the Schiötz tonometer was adopted a new conception of the normal intraocular pressure was introduced. The Gradle

tonometer is a copy of the Schiötz and Dr. Gradle wrote me that he used a Schiötz tonometer to determine the scale for his tonometer.

My experiments tend to revert to the standard as established by Wahlfors and the early experimenters, rather than the newer scale put forth by the Schiötz tonometer.

The first reference I found in literature to increased intraocular pressure was that of Mackenzie who in 1830 observed that a hardness of the eyeball occurred in glaucoma. The importance of the correct conception of the intraocular pressure has been admitted since the full force of Mackenzie's discovery became manifest, and we find in looking over the history of ophthalmology that investigators early appreciated the inaccuracy of the estimation of intraocular pressure by the digital method.

The manometer in actual connection with the interior of the eye and with a perfect technique is the only method known to-day of obtaining absolutely accurate conceptions of the intraocular pressure.

The first records of experiments in ophthalmo-manometry that I could find are those of C. Weber in 1850, but he fails to draw any conclusions as to the normal intraocular pressure. Later, Wahlfors made some experiments with the human eye *in situ* in connection with the manometer, and in some correspondence I had with Professor Fuchs, he advised me that my experiments were in harmony with those of Wahlfors.

The usual method of determining the intraocular pressure experimentally has been to introduce a canula into the interior of the eye, and attach a manometer by means of tubing to the canula. Both the water and mercury manometers have been employed, depending on the construction of the apparatus.

Many experimenters have made investigations into intraocular pressure, and generally dogs, rabbits, and cats have been used. The conclusions reached are that the normal intraocular pressure of these animals ranges from 18 to 35mm. Hg.

In constructing an apparatus for my experimental work on eyes *in situ*, I tried to incorporate the good features of the apparatus used by previous investigators with improvements of my own design. I made a canula having a tempered steel needle, the opening in the needle being on the side. The taper conformed to an angle of two degrees and had two flat sides. I made two needles, the lumen of the one used for work in connection with the anterior chamber was 0·8 mm. in diameter, while for use in the vitreous, a needle of 2 mm. bore was used.

To overcome any possibility of altering the original pressure of the eye by the volume of metal thrust into the eye, a needle valve was interposed in the lumen just far enough back from the opening to compensate for the volume of the metal in the eye. A half turn of the valve was sufficient to open the needle completely.

Investigators have repeatedly found that the canulas of small bore will become clogged when used in connection with the vitreous chamber. I discovered while working on the living eye that my needle of 0·8 mm. bore could not be depended on when it was in connection with the vitreous chamber, but it worked very nicely in the aqueous chamber. With the 2 mm. needle I had no trouble.

One experimenter has published his results of work done along the line of intraocular pressure with the Schiötz tonometer when he used a canula of 0·8 mm. bore on eyes of the dead human being. During life the pulsations imparted to the fluid of the testing apparatus which comes in contact with the contents of the interior of the eye is an indication that the canula has not become clogged. With dead eyes there is no pulsation to aid the experimentor, so it is impossible to know that the apparatus is working properly. I made these experiments before the paper referred to above was published. After reading the article, to satisfy myself as to the value of experiments with an 0·8 mm. needle in the vitreous, I repeated the experiments and found they verified my first conclusions.

In my work the canula was connected to a thirty-inch-long glass capillary tubing by short lengths of rubber pressure tubing. The total volume of fluid contained in the capillary tubing was about ten minims. The other end of the glass tubing was connected through a T piece to a manometer and a reservoir. The object of the capillary tubing was to enable me, by means of a small air bubble sucked halfway up the tubing, to compare and equalise the manometer and the intraocular pressures.

A water manometer was used, but it was graduated to its equivalent in millimeters of mercury. The reservoir was suspended and was capable of adjustment as to height, in order to alter the manometer pressure at will. Figure 1 shows a cut of the apparatus. Figure 2 shows an enlargement of the canula needle.

In using the apparatus the needle was introduced with its valve closed and the connected manometer registering the estimated intraocular pressure. The position of the air bubble was marked, and when all was in readiness, the valve was given a half turn and the movement of the air bubble noted. If the bubble moved toward the manometer it indicated a greater intraocular than manometer pressure and vice versa. A manometer pressure was obtained which caused the bubble to remain at, or, in case of movement, to return to, its original position. A reading of the manometer was then made. Great care had to be exercised to prevent any traction or pressure of the needle on the eyeball.

To the present time, of living animals I have employed rabbits, dogs, and cats and four living human eyes.

I have been particularly fortunate in being allowed to make experiments on four living human eyes *in situ*.

In a paper which I read before the Section of Ophthalmology of the Academy of Medicine, New York City, I presented the results of experiments performed on the eyes of rabbits and dogs and the experiments on three living human eyes *in situ*. Since then I have been further favoured in being allowed to make similar tests on another living human eye *in situ*.

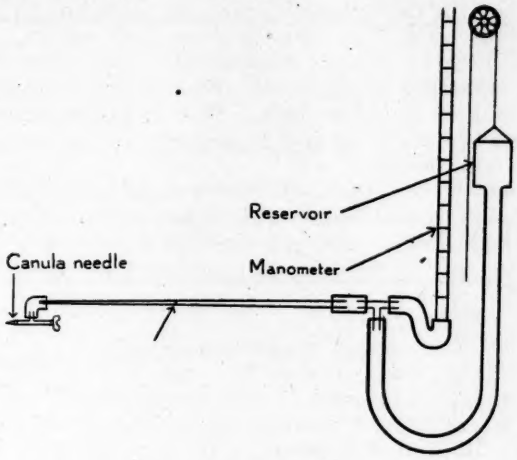


FIG. 1.

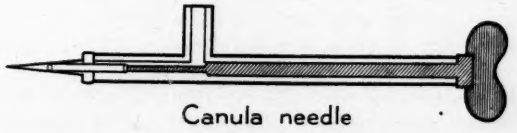


FIG. 2.

In my experiments an observation was made, one which I had never read or heard of: that the tonometer registered a difference in intraocular pressure under local, and immediately after under deep general anaesthesia. The animal was first cocainized and the intraocular pressure determined by tonometer, then after administering the general anaesthetic the tonometer was again used before any other instrumentation was done. With the human cases holocain was used for local anaesthesia instead of cocain, but approximately the same proportion of difference prevailed.

Since that paper was published I have received letters from oculists stating that since reading my article they have looked for and found a difference in intraocular presssure in local and deep general anaesthesia.

I made one set of animal experiments for the purpose of determining the relation of intraocular pressure to the depth of ether anaesthesia. In those experiments the canula here described was inserted into the eye. As the anaesthesia progressed, the intraocular pressure became lessened until a point was reached where for a period no drop in the intraocular pressure prevailed. The ether cone was removed and the animal allowed to recover. As the animal was about to regain consciousness, it was noted that the manometer registered approximately the same intraocular pressure as at the start of the anaesthesia. This also demonstrated that we had a perfect connection and no leakage around the canula at its insertion into the eye.

The purpose of the experiments in this paper is to determine the relative accuracy of the Schiötz and McLean tonometers, using a living eye *in situ* and connecting it directly to a manometer.

I might add that all the tonometer readings were made by others than myself.

### Animal Experimentation

The general plan followed in this series on cats was first to determine the intraocular pressure under cocain using both the Schiötz and McLean tonometers. The cat was then etherized and readings again taken, after which the canula was inserted and readings taken to determine any alteration in pressure caused by the introduction of the needle into the eye. (In all of my experiments it has been observed that on account of the position of the valve in the canula, the alteration of pressure by the introduction of the canula into the eye was a negligible quantity.)

With this system we were able to alter the intraocular pressure at will and make comparative readings with both tonometers.

CAT 1.—The eye was cocainized and a Schiötz tonometer reading of 17.5 mm. Hg. was made. At the same time the McLean tonometer recorded a pressure of 32 mm. Hg. The animal was then etherized and the Schiötz recorded 10 mm. Hg. while the McLean registered 22.

The canula with its valve closed was inserted into the vitreous chamber and the Schiötz recorded 10; McLean, 22.

The valve of the canula was then opened and a manometer pressure of 25 mm. Hg. was necessary to keep the air bubble at its original position. This showed us that the actual intraocular pressure at that moment was 25 mm. Hg.

Subsequently manometer pressures of 20, 40, 50, 70, 90, 110 were produced and readings with both the Schiotz and McLean instruments were made.

After the experiment the eye was enucleated and connected to the manometer when comparative readings were again made.

Chart 1 shows graphically the results of this test.

CHART 1

| | | | McLean. | Schiötz. |
|---|---|---|---|---|
| Cocain | 32 | | | 17.5 |
| Ether | 22 | Before inserting canula. | | 10 |
| Ether | 22 | After inserting canula. | | 10 |

Manometer with air bubble 25 mm. Hg.

| | McLean. | | Schiötz. | |
|---|---|---|---|---|
| Manometer mm. Hg. | In Situ. | Enucleated. | In Situ. | Enucleated. |
| 20 | 19 | 23 | 7 | 10 |
| 30 | — | 34 | — | 20 |
| 40 | 40 | 43 | 21 | 24 |
| 50 | 50 | 52 | 38 | 35 |
| 60 | — | 60 | — | 37 |
| 70 | 70 | 72 | 52 | 53 |
| 80 | — | 82 | — | 65 |
| 90 | 90 | 93 | 72 | 76 |
| 100 | — | 102 | — | 70 |
| 110 | 110 | 110 | 78 | 72 |

CAT 2.—With the eye under the influence of cocain the Schiötz reading was 17·5 and the McLean 32. Under ether Schiötz was 10 and McLean 23. After the needle was inserted the Schiötz recorded 11, and the McLean 22, then the valve was opened and the intraocular pressure was found to be 22 mm. Hg.

Manometer pressures were produced the same as in the previous test and corresponding readings taken which are shown in Chart 2.

CHART 2

| | | | McLean. | Schiötz. |
|---|---|---|---|---|
| *Cocain* | *32* | | | *17·5* |
| Ether | 23 | Before inserting canula. | | 10 |
| Ether | 22 | After inserting canula. | | 11 |

Manometer with air bubble 22mm. Hg.

| | *McLean.* | | *Schiötz.* | |
|---|---|---|---|---|
| Manometer mm. Hg. | In Situ. | Enucleated. | In Situ. | Enucleated. |
| 20 | 20 | 23 | 10 | 5 |
| 30 | — | 32 | — | 18 |
| *40* | *39* | *44* | *26* | *31* |
| 50 | 46 | 54 | 31 | 37 |
| 60 | — | 64 | — | 42 |
| 70 | 68 | 72 | 47 | 48 |
| *80* | — | *82* | — | *55* |
| 90 | 90 | 90 | 60 | 65 |
| 100 | — | 100 | — | 68 |
| 110 | 110 | 108 | 68 | 70 |

CAT 3.—With the eye under the influence of cocain the Schiötz reading was 24, and McLean 33. When the animal was thoroughly under ether the Schiötz reading 13 and McLean 23 was recorded. With the needle inserted the Schiötz again registered 13 and McLean 24. When the valve was opened the manometer pressure which sustained the bubble was 22mm. Hg. Chart 3 shows the results of readings made, altering the manometer pressures as in the previous tests.

CHART 3

| | | | McLean. | Schiötz. |
|---|---|---|---|---|
| Cocain | 33 | | | 24 |
| Ether | 23 | Before inserting canula | | 13 |
| Ether | 24 | After inserting canula | | 13 |

Manometer with air bubble 22 mm. Hg.

| | McLean. | | Schiötz. | |
|---|---|---|---|---|
| Manometer mm. Hg. | In Situ. | Enuc. | In Situ. | Enuc. |
| 20 | 19 | 22 | 11 | 10 |
| 30 | — | 30 | — | 18 |
| 40 | 40 | 40 | 24 | 24 |
| 50 | 48 | 49 | 28 | 32 |
| 60 | — | 62 | — | 44 |
| 70 | 70 | 71 | 51 | 51 |
| 80 | — | 82 | — | 54 |
| 90 | 90 | 90 | 58 | 60 |
| 100 | — | 104 | — | 75 |
| 110 | 108 | 112 | 71 | 84 |

The tonometer readings on the animal eyes were made by Dr. Holzapfel. Dr. Hallett used the tonometer on the human cases. The human eyes tested were all glaucomatous, and were being removed on account of an uncontrollable pain. The experiments of the first two were performed before I had my tonometer perfected; on the third and fourth both the Schiötz and McLean tonometers were used.

The fact that I have had the privilege of experimenting on four living human eyes *in situ* is of sufficient importance to warrant a review of the three cases recorded in a former article.

The fourth case has not been previously recorded, and was demonstrated at the Clinical session of the June, 1919, meeting of American Homeopathic O. O. and L. Society in New York City.

In the first human case tonometer readings were made on both

eyes under holocain anaesthesia. The tension of the affected eye was 75, while the healthy eye registered 19 Schiötz. Under ether the affected eye registered 45, and the healthy eye 10 Schiötz.

A canula, as described before with a bore of 0·2 mm., was thrust into the vitreous chamber well back of the ciliary processes. After the position of the air bubble was marked, the valve was opened. It was found that a manometer pressure of about 65 mm. held the bubble at its mark. With the needle in the vitreous chamber we were able to make tonometer readings and compare them with the manometer, which readings were as follows:

| Manometer pressure. | | Schiötz's tonometer. |
|---|---|---|
| 65 | ... | 50 |
| 65 | ... | 50 |
| 64 | ... | 43 |
| 66 | ... | 50 |

Tests made on this same eye after it had been enucleated gave the same ratio of variance between the manometer and Schiötz tonometer in all pressures of 10 mm. to 120 mm. Hg. as may be noted by Chart 4.

## CHART 4.

Human eye *in situ* used at the hospital for tests with water manometer and Schiötz tonometer. (Diag. Glaucoma Absolutum, O. D.). Manometer needle, 2mm. bore, with valve, and glass capillary tubing, 30 in. long and 1mm. bore. Needle was connected with vitreous chamber.

| | O.D. Schiötz. | | O.S. Schiötz. |
|---|---|---|---|
| Before anaesthesia | 75 | | 19 |
| During anaesthesia | 45 | Manometer | 10 |
| " " | 50 | 65 | |
| " " | 50 | 65 | |
| " " | 43 | 64 | |
| " " | 50 | 66 | |

Same human eye (enucleated):

| | Schiötz Tonometer | | | |
|---|---|---|---|---|
| Manometer mm. Hg. | 15 Gm. | 10 Gm. | 7.5 Gm. | 5.5 Gm. |
| 120 | 105 | | | |
| 110 | 96 | 86 | | |
| 100 | 86 | 71 | | |
| 90 | 58 | 65 | | |
| 80 | 53 | 60 | | |
| 70 | 42 | 56 | 62 | |
| 60 | 33 | 51 | 43 | 43 |
| 50 | 23 | 32 | 31 | |
| | | | | 35 |
| 40 | 14 | 23 | 20 | 22.5 |
| 30 | 6 | 14.5 | 19 | 16 |
| 20 | x | 6. | 11.5 | 7.5 |

On the second human case tested, readings were made of the affected eye only. Before general anaesthesia a Schiötz tonometer reading of 88 mm. was made, and at the first reading under general anaesthesia the Schiötz recorded 72 mm. Hg. The canula was immediately inserted and the Schiötz again recorded 72, which shows that the insertion of the needle made no change in pressure. The valve was opened connecting the interior of the eye with the manometer and a manometer pressure of 88 mm. was required to keep the air bubble in its original position.

As the anaesthesia was increased tonometer and manometer readings were made, which were:

| Manometer | Schiötz Tonometer |
|---|---|
| 86 | 72 |
| 81 | 54 |
| 72 | 47 |

As the anaesthetic was continued there was no decrease of intraocular pressure below 72 (manometer), so the experiment was concluded and the eye enucleated.

On the third human case both the Schiötz and McLean tonometers were used. On account of the condition of the patient we were allowed time to make only one reading with each instrument. In my haste I perhaps chose a faulty location for my canula as it was with difficulty that we could keep a connection of the interior of the eye open to the manometer as evidenced by the diminished oscillations of the air bubble, while in the other cases the bubble oscillations were readily discernable all the time the valve was open.

The readings of this case were, Schiötz 40, McLean 58, and the manometer recorded 60 mm.[1]

On the fourth human case, under holocain, a reading was made of 46 Schiötz, and 70 McLean. After the patient was etherised a reading was made of 43 Schiötz, and 62 McLean.

The needle was inserted with valve closed as in the other cases and a reading was made of 43 Schiötz and 63 McLean.

The manometer was adjusted to a pressure of 43mm., the pressure as recorded by the Schiötz tonometer, and the valve of the canula was then opened. As soon as the valve was open, the air bubble started toward the manometer. This showed us that the intraocular pressure was greater than the pressure of the manometer. There was also a slight oscillation of the air bubble which was synchronous with the heart and by that oscillation we were assured that a good connection between manometer and eye existed. The

[1] The demonstrations of the human cases above cited were all made at the New York Ophthalmic Hospital in the presence of eye specialists. At the demonstration of the third case about thirty oculists were present and of the fourth case about forty.

manometer pressure was raised until the air bubble was driven back to its original position, and it was found that a manometer pressure of 65 mm. Hg. sustained the air bubble at that point. The indication then was that the true intraocular pressure was 65 mm. Hg.

It may be noted in all the experiments on the living eye, both human and animal, that the intraocular pressure was highest under local anaesthesia, and as soon as the patient was thoroughly under the influence of the ether the pressure was lowered; the deeper the anaesthesia the lower the pressure until a limit was reached.

Chart 4 shows the readings made on the human eye in situ, and the corresponding readings after the eye was enucleated. It has been suggested that inasmuch as the large number of tests I made on living eyes *in situ* agreed with the tests of those same eyes after enucleation it is pretty good evidence that my testing apparatus for enucleated eyes is fairly correct.

When I began my work on the tonometer I had not the slightest idea I would run counter to the good work of Prof. Schiötz. My only thought was that it was possible with a new instrument to render a refinement in tonometry.

I trust you will not consider this paper as an attack on the Schiötz tonometer.

The values of the Schiötz and McLean tonometers are not the same, and I have shown the differences in the readings of the two instruments in association with the manometer merely to substantiate my claims for the scale I have adopted on my tonometer.

In seeking, first, a method of testing out my tonometer, I used the Schiötz as a basis of measurement, and I discovered that I could not make the Schiötz and manometer agree, yet could not find anything wrong with my testing apparatus. I called on several oculists for assistance, and they were unable to suggest a fault in technique or apparatus. I then consulted a professor of physics of Columbia University, and he assured me my apparatus was correct, and if a discrepancy existed the fault must lie in the tonometer. At this same time I was working out the new features for my tonometer, and the first McLean tonometer I constructed entirely myself, as I did also all the canulas used in my experimental work.

At another time I invited a professor of physics of the boys' high school to inspect my testing apparatus from the standpoint of physics, and he reported to the Section of Ophthalmology, Academy of Medicine, that he had examined the apparatus, and saw tests made, and found everything in perfect keeping with the laws of physics.

I showed my tonometer to Mr. E. B. Meyrowitz when it was all

finished except the scale, and he asked the privilege of manufacturing and placing the instrument in the hands of the oculists.

The late Dr. Marple was one of the oculists who saw some of my early experiments, and I mentioned to him that I intended writing Prof. Schiötz regarding the discrepancy I found. Dr. Marple asked if I would allow him to communicate to Prof. Schiötz what he had seen of my experiments, and send him a description and drawings both of my testing apparatus and the results of my tests, as Dr. Marple and Prof. Schiötz were close friends. I allowed him the courtesy he asked, and furnished him with a drawing and description of the testing apparatus, also a tonometer to send to Prof. Schiötz. The McLean tonometer was in Prof. Schiötz's possession over six months, and in his reply he failed to criticize the testing apparatus or the results.

My testing apparatus for enucleated eyes consists of a water manometer, with its necessary connections of glass and rubber tubing; a canula connected to a stop-cock by short length metal tubing, to which is attached the apparatus which I have termed a pulsator.

I have used both the mercury and water manometers, and found the water manometer more convenient for use. The results were the same, as of course they should be.

The canula I made with a 2 mm. bore and made a trocar to fit, so that it could be inserted through a sufficiently long stump of optic nerve into the vitreous chamber.

The connection between the eye and stopcock is made entirely of metal to avoid the possibility of expansion by a more elastic substance.

The pulsator is an apparatus which I have constructed to simulate the pulsations of the arteries of the living eye. You have all noted in using the tonometer that there are oscillations of the needle which are synchronous with the heart beat. My apparatus causes these same slight oscillations of the indicating needle. The apparatus is run by clockwork.

### The Testing of McLean Tonometers

For testing tonometers, the enucleated eyes *must not* be kept in any hardening or preserving fluid and should be used as quickly as possible after enucleation. A few hours is sufficient to alter the resiliency of the tunics of the eyeball for testing purposes. They must be absolutely fresh.

While the eye is being used in the testing apparatus, it is ensheathed in a rubber cap which acts similarly to Tenon's capsule. This cap is of extremely thin high-grade rubber tissue and is sufficiently large so as not to be put at all on the stretch when the

eye is placed in it. It encases the eye almost to the margin of the cornea, and acts as a reservoir to hold the normal salt solution which keeps the eyeball from becoming less resilient.

Before using the eye it is cleared of all extraneous material down to the sclera. The imitation Tenon's capsule is adjusted and the canula with its trocar is passed in through the centre of the stump of the optic nerve until the opening is in the vitreous chamber, when the trocar is withdrawn. A perfectly tight joint must be obtained, and the canula adjusted to the short metal tubing connected to the stopcock.

Outside the rubber tunic an adjustable ring support around the optic nerve acts as a base to support the eye without inducing any pressure or traction.

As soon as the eye is placed in position, I fill the rubber tunic with normal salt solution. This keeps the eyeball from becoming less pliable, as the eye under pressure changes quite rapidly by contact with the air.

When all is in readiness the stopcock is opened. The pressure of the liquid should be raised in the manometer until the correct height is reached. (Do not proceed from a greater to a lesser pressure). After the desired pressure is obtained an interval should elapse to allow the tunics of the eye to become adjusted to that pressure before a reading is made.

I have a normal salt solution at hand, also a pipette with which I am constantly dropping the normal salt on the cornea before each application of the tonometer. The stopcock remains open, except when it is closed to make a tonometer reading. It is opened immediately after the reading and remains open until the next reading.

With this apparatus I am able to obtain any pressure from 0 to 135mm. of mercury.

It was by actual tests with this manometer, using several tonometers on repeated readings, that the present scale on the McLean tonometer was adopted.

With this tonometer the lower limit of normal intraocular pressure is to be considered as 22, while I have not found a normal eye registering above 40. I have placed the upper limit at that figure because I have found eyes registering 40 in which there were no symptoms, subjectively or objectively, of glaucoma. It is difficult to give an absolute limit of normal pressure. I have found a few eyes that registered as low as 36 with the McLean tonometer and 22 with the Schiötz, in which symptoms of glaucoma were present.

Altogether, in my experimental work, I have tested over two hundred enucleated eyes, and a considerable number of eyes *in situ* of the lower animals.

Aside from the work of Weber and Wahlfors, I think I am the only man who has done any experimental work on living human eyes *in situ*, by connecting the interior of the eye to a manometer.

## THE VISUAL PERCEPTION OF SOLID FORM.*

BY

E. M. EATON.

(*Concluded from p.* 340)

In the circumstances which lead to the perception of double images a small amount of non-identity of direction can be overcome by the tendency to achieve single vision. This is accomplished by error of projection, and the limits within which it is possible are those which have been described as the limits of fusion. As the underlying cause is in effect illusion of form, they are probably closely associated with the limits of illusion.

The mechanism of binocular vision, as I conceive it, may be summarized as follows:

1. The vision of each eye remains physiologically independent except as regards fixation; apart from this the unification of the two images has reference to the object perceived not to the means of perception.
2. The physiological axes of vision are interpreted as occupying their actual positions, the lines passing through the point of fixation and the nodal points of each eye.
3. The perceptive axis of vision lies between the fixation point and the middle of the interocular space. Its use involves a psychic modification of all visual angles similar to that which enables us to interpret foreshortened images in accordance with their true values.
4. The perception of position in three dimensions is a function of the sense of directional projection of the two eyes. The perception of relative position in three dimensions is a function of the sense of relative directional projection of the two eyes.
5. Double images result from a certain degree of perception of the subjective element in the sense of sight, with consequent alteration of the foregoing relationships.

If binocular impressions are but a phase of projection sense impressions, or more inclusively of form sense impressions, there can be no subjective reason, no reason on the ground of a specific feeling quality, why the vision to which they give rise should differ

* A paper read before the Ophthalmological Section, Royal Society of Medicine, on June 4, 1919.

in category from that afforded by other actions of the form sense; no reason, that is, why the former exclusively should excite stereoscopic consciousness. If there is no subjective reason may there be any objective reason? It is said that by means of binocular vision we see around things, we see the spaces behind them.

We, of course, cannot in the ordinary sense of the word see spaces, yet we may in effect do so to some extent. Those who have looked across a desert plain beneath a tropical mid-day sun will have noticed the appearance of ceaseless motion in the air due to the ever altering states of its refraction. In such circumstances the atmosphere has a very definite effect on our consciousness of spaces. If we look at the objects on the bottom of a pond through a few feet of water the conditions of lighting and reflection are characteristic, and if we are conscious of the medium we must thereby be assisted in our consciousness of the space which it occupies. The variations in the effect of the atmosphere at short distance do not in ordinary circumstances appear to influence our perceptions, but anything which can sufficiently intensify or appear to intensify this factor may affect our vision.

To say that we can see the spaces behind objects is a different matter however. It depends on the question whether it may be possible to see behind an object at all. If the obstructing object is broader than the interocular distance we shall not see more of the object in the background than we would with a single eye if we were at a greater distance; in other words the factor can then be at the most one of degree only, and not of type. If an obstructing object is narrower than the interocular space, and especially if it is so narrow that our lines of central vision can meet behind it, then provided the conditions cause us to notice that we do see behind it, the effect is that we see through it; we also get double images, one of which may be suppressed. Each image of the intervening body will be seen with one eye, and the background behind it with the other. As a result we shall get transparency of the obstructing object, for the lines of psychic projection of the background pass through its images. This can be observed with a pencil against a printed page. Under no circumstances do we see around an object, nor do we see behind it in any but the special case of false projection with transparency, and this is obviously not stereoscopic vision.

I have already referred to the influence of looking at objects through water, and the characteristic lighting which results from it. A similar effect is commonly seen in stereoscopic pictures. The view looks as if bathed in an atmosphere approaching in its effect to that of submersion in water. This is due to stereoscopic lustre. The appearance is produced by the superposing of a light

surface on a shaded one, and with the exaggerated displacement* which is used in the making of our stereoscopic pictures this occurs to an undue extent. It adds beauty to the view, a result which is incidental, and it is one of the reasons that the study of those pictures is apt to make us attribute so much importance to binocular vision.

It sharpens the margins of objects and tends to cut them more clearly apart from the objects behind by suggesting the effect of atmosphere in the vacant spaces, while other factors determine the actual position at which each object will be placed. Binocular vision is in this manner an assistance to stereoscopic vision, although not so greatly in observation of solid bodies as of photographs, for in the former case much more of the lustre of objects is appreciable with one eye.

Stereoscopic lustre is commonly attributed to rivalry of the sensations of light and dark on the two retinae, and to consequent oscillations of light perception; from this it follows that it differs physiologically from lustre as appreciable with one eye. It may be explained on a much more definite basis however.

An object exhibits lustre, or shines, when it gives off light apart from that which we interpret as the visible existence of the object itself. The physical cause commonly underlying this differentiation is regular reflexion, as distinguished from diffusion or irregular reflexion. With regard to perception, the light emitted by objects, excluding for the moment those that are self-luminous, may be divided into two categories, according as it appears to us as an inherent character of the object, or as a reflex which, owing to our experience of the variabilty of reflex light, carries the suggestion of extraneous origin. In the former case there is no consciousness of light as such; in the latter there is.

The light which is observed to be of reflex origin, although it is felt as something additional to the fixed identity of the object itself, is none the less referred to the object as medium in ordinary circumstances; it thus plays a part in our perception of the object, and in the case of clean metallic surfaces it is almost the sole means of perception. This produces the peculiar character of metallic lustre; hence the reflection of white light in sufficient quantity from a black surface, or from an otherwise vacant one like that of a totally reflecting prism, will exactly simulate the appearance of polished silver.

The characteristic quality of the lustre of metals depends upon

* The geometrical effect of excessive distance between the cameras is to make a view representing a reduced model of the subject. This effect, however, is associated only with the degree of dissimilarity of the images, a factor sufficiently small that it is readily overcome by the other guides to size and distance such as the presence of objects of approximately known size, just as similarity of images can be overcome and a depth estimate maintained.

low absorptive power and high degree of opacity of the lustrous surface. This causes a bright reflex, and allows of no transmission of diffused light from irregularly disposed particles beneath the surface.

As it is possible to refer the variable or reflex light to an external source, it follows that under certain circumstances metals ought to be invisible, and this is in fact true. A piece of freshly broken metal shines for the unevenness of its surface does not cause general diffusion but rather multiplication of reflexes; if we polish it moderately it shines more, for we can see more of the reflexes simultaneously; but if we polish it highly there comes a limit when, regarded in a certain way, it ceases to shine, it becomes a mirror; and a perfect mirror has no lustre, it is invisible. The images formed by means of a mirror may themselves shine of course. If we direct the attention to the plane of a mirror, however, using its visible borders or any defects on its surface as guides, we can then regard it as we ordinarily do a piece of metal, and it becomes possessed of the very acme of metallic lustre: the difference between this and invisibility is purely one of mental attitude.

In the case of polished metallic objects in general the indications of contour and surface afforded by the reflexes, serve as an ample basis of definite perceptions, and the almost total absence of diffused light completes the requirements for the perception of metal. The light of self-luminous bodies, of flames, electric lamp filaments, and the stars, resembles reflected light owing to its being intensely brilliant relatively to the surroundings: such bodies thus appear like highly illuminated metallic objects.

Lustre is not due to failure to focus light on the retina for we may accurately focus the light from a mirror by looking at the images beyond it and, while so doing, by attending to the mirror itself we can still accept the interpretation of lustre; similarly with an electric lamp we may focus the filaments accurately, but they remain still lustrous. When lustre is uneven it may cause a sparkling effect; this is sometimes confused with lustre itself, but it is merely a frequent accompaniment or variety.

Lustre is not due to special physical properties of the light, for we may have a choice whether we shall see it or not. In the case of the metals, the imperfections and the form of the surfaces ordinarily so modify the distribution of the reflected light that we have not the choice that is available in the special instance of mirrors: in their particular case, however, the same light appears as lustre or as material reality according as we think of it in relation to the mirror or to the images; in relation to the former it is perceived as reflex light, in relation to the latter it is not differentiable from the objective being of the images themselves.

When we look at a painting of a soap-bubble, suggestion or voluntary decision determines whether we see lustre or white, blue, green, and other colours of paint.

Lustre is not a specific physiological sensation, it is a specific psychological interpretation. It depends upon the conception of light as a separable idea from that of the object with which we associate it, a conclusion resulting from one or another cause of apparent incongruity of light intensities.

When we combine in the stereoscope a black figure with a white counterpart, we get an image varying somewhat in its shade of grey, as the attention sways more to this side or to that, but all the while shining. Now if the intensity of light falling on the two retinae differs in degree, the perception of brightness is less than that which would be perceived through the more illuminated eye were it acting alone, a phenomenon which is known as Fechner's paradox. It follows that in a stereoscopic combination where there is marked difference in brightness of the two images there is a superfluity of light on the retina which receives the brighter image; there is light beyond that which is interpreted as the visible existence of the object itself, therefore the object shines; in the case of a black and white combination the conditions are analogous to those we have seen to be requisite for the perception of a metallic surface.

The underlying cause of the uniocular and the binocular perception of lustre is thus identical.

The only information of a specific type made available by the binocular factor, consists of certain angular relationships determinable by means of the projection sense. But the interpretation of binocular projection sense impressions requires as a preliminary the correlation of the projection systems of the two eyes. In some circumstances, as in the falling beads experiment or in the observation of points of light in the dark, this is achieved by the attributing of identical origin to the images occupying the foveae. If we block out both foveal images, however, as by holding a pencil transversely about an inch in front of the eyes, we still see in the upper and lower parts of the peripheral field with the full efficiency of our binocular vision. The correlation can now take place only by the comparison of form sense impressions which, as the images are not identical, implies the assumption of their objective significance, and this in its turn involves a reference to preconceived form. This is probably the more common means of correlation, for ordinarily our attention is not confined to the actual point of fixation. It will be observed that the essential difference between foveal and eccentric lines of co-ordination is that in regard to the former, the visual angles are subject to no psychical modifications. When the value of the visual angles is zero,

differences of proportion due to foreshortening of images are without influence. Hence the line of foveal vision is the line of reference; whether available for actual vision or not, it is the axis in relation to which eccentric visual lines must first be co-ordinated before they can acquire the perceptive significance necessary for their truthful application in correlating the vision of the two eyes.

Now we have in the sense of perspective—that is, mathematical perspective—another means of determining position in the third dimension, through the relationship of form sense impressions to preconceived form.

From early times the sense of perspective has been recognized by painters as contributing to the effect of relief. For many years it has been accepted as one of the criteria of distance, that is as a factor in the sense of depth, which, although it is but relief considered in the opposite direction, seems to imply a little more. In the early days of photography it was noticed that photographs made with long focus lenses gave this effect more fully than those made with lenses of higher refraction. This is due to our receiving a more correct perspective impression, which can be obtained with exactitude only if we view the photograph from the position of the lens with which it was made.

The principles governing the obtaining of correct perspective from photographs were first enunciated by Gullstrand, and a specially constructed periscopic lens for realizing the conditions has been designed by von Rohr* at his suggestion. The effect obtainable with it is very realistic even with a single eye.

Although we get true perspective from the distance of the focal length of the lens, this does not of itself explain why we get greater stereoscopic effect. When we view a photograph from too great a distance the effect on the perspective from a geometrical point of view is one of two things: either the distances in depth are exaggerated, or else objects further forward are enlarged relatively to objects further back. The former alternative therefore ought to increase the relief, the latter to cause distortion of the subject. We do not get increased relief in looking at a photograph in the ordinary way, however, we lose in relief; neither do we get distortion. If we are critical we are displeased with the perspective certainly, and if we are able to analyse it we know that the proportions are wrong, but we have no illusion as to the true shapes of the objects represented.

We recognize the picture as a photograph, which, in order that it should give a symmetrical impression, must be looked at from a view-point other than that which we occupy. The retinal image

* von Rohr, *Brit. Journ. Photog. Almanac*, 1905.

to which it gives rise, therefore, does not comply with the requirement of being, according to our habit, characteristic of a solid object. Consequently we do not see solidity. We see simply a photograph.

As it is the sense of form which is appealed to in both the binocular sense and in the sense of perspective, we might anticipate that they would be equal in stability, but they are not so. The degrees of difference of directional projection with which the sense of perspective has to deal are much greater than those available to binocular vision, except in the case of very small objects. A much greater error of projection is therefore necessary to permit of its being deceived; it is less susceptible to illusion.

This may be illustrated by an example.

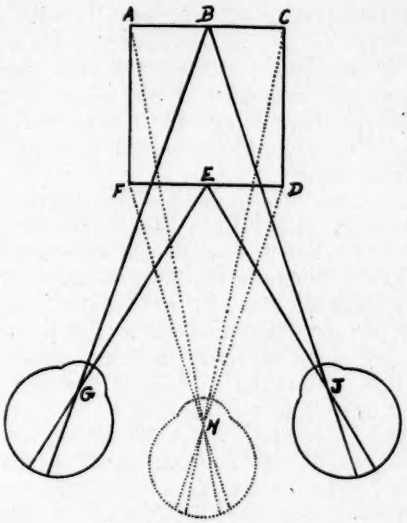


FIG. 6.

A F D C represents a square or skeleton cube of one foot breadth, seen at a distance of 10 feet from its nearer side; and we may represent the binocular view of two points E and B by the continuous lines in the figure, and the uniocular perspective view of the corners by the dotted lines. The angles concerned are E G B and E J B in the former case, and A H F and D H C in the latter. Drawn as in the figure the object is small relatively to the interocular distance, therefore, the perspective angles are the smaller, but if it had been drawn to scale on the measurements given, the angles for perspective would have been 16 minutes, and

for binocular vision 3 minutes. The larger the object the greater the ratio in favour of perspective; for rectangular shapes the proportions are approximately as the breadth of the object is to the interocular distance. Consequently in average circumstances in the streets of a town, or in the rooms of our houses, the sense of perspective is a much more certain, more useful, and more commanding factor than binocular vision. There is, therefore, every reason on theoretical grounds to expect its part in producing the quality of stereoscopic vision to be greater also. If we take converse circumstances where the object is very small, as in the favourite example of the threading of a needle, then perspective acts so feebly as to be no material assistance, and binocular vision becomes of paramount importance.

There are many other factors which contribute to the building up of our solid visual images; and while I have spoken chiefly of the sense of form or relative projection, I do not wish to give the impression of attaching little importance to factors dependent on other fundamental functions of our sense of sight. I have excluded also all questions of eye movements for, while they are of great value, it is universally accepted that stereoscopic vision is possible without them.

I have here a number of stereoscopic photographs, some of which are mounted normally, others are reversed, and a few are duplicates. They are intended to show the great ease with which the binocular sense will give way in favour of the more imperative demands of the other factors, in particular those of the sense of perspective. If one of the reversed pictures is examined it will be found that although there is some discomfort of vision the appearances are practically normal, but if it is turned top to bottom the objects in the foreground will tend to pass to the back, and vice versa. The reason is that the sense of perspective at first fails to apprehend the meaning of the picture, and is in abeyance, so that the binocular function is free to make the reversal which in the erect position also it would do were it not for the conflict of other and greater evidences.

I have also some ordinary pictorial postcards; these should be viewed with a single eye through a + 8D lens to get the natural perspective effect. This principle is not a new one, and the ordinary biconvex lens is in fact a very imperfect one for the purpose, but I show the pictures in order to illustrate the possibility of getting stereoscopy with one eye. I know that there may be differences of opinion whether this is achieved; some will agree that the view is stereoscopic and some may feel that while it is much improved something is wanting as compared with the binocular view.

I would repeat, however, that in order to obtain stereoscopic perception the visual impression should be characteristic of solid

objects, and that the observation of these characteristics should be habitual. The single correct perspective view fulfils the first condition, but only in part does it fulfil the second condition for people accustomed to use two eyes.

The question is not whether binocular vision is a factor in stereoscopic vision, that is accepted; but is it essential? The ultimate test must be against solid objects; photographs at the best are but imperfect imitations and the incidental factor of lustre is difficult to eliminate. With reversed pictures, however, the effect of stereoscopic lustre is present as in the normally placed ones; hence those pictures are often more effective than duplicates, despite the greater antagonism of the binocular projection sense. This fact is an index of the degree in which the binocular contribution to stereoscopic appearance is due to this condition, a condition which derives much of its importance from the incidental circumstance that our photographs fail to reproduce natural lustre convincingly.

If we compare the uniocular and binocular perception of a book as seen at a few feet distance on a table; if we choose any view that does not place one or other set of factors in unusual predominance, and compare the two effects; is there any difference in the category of visual feeling which results? In my experience there is not.

The uniocular factors in stereoscopic vision are sometimes spoken of as the psychological factors. Binocular vision is no less a psychological factor, analogous in its mental relationships to the function of perspective vision. Whether we hold the view that perception is unconscious inference, or, that which probably most of us prefer, that it is a mental act of a more immediate type, there would appear to be no ground to differentiate between the perception of flat objects and the perception of solid ones, between the perception of solids objects by one means and that by another. Each is the product of a sense impression and past experience.

If from a natural view we eliminate experimentally its colouring, its shadow effects, or any other of the stereoscopic guides which it affords, our mental image will lose some little part of its exquisite realism. If, then, we eliminate our binocular vision we shall expect the view to fall in some degree in quality, but we do not lose the sensation of solidity, and that is the criterion. The binocular element in vision contributes a valuable quota to stereoscopic perception, but it is one of many factors. The relative part played by each factor varies in degree with the type of view, and no individual factor is universally essential.

If from the retinal stimulus, and consequently from our physical impression, we take away any one of the features of solidity, then the sensation is less vivid, but the perception of form does not vary.

The absence of binocular vision is a disadvantage, but I doubt if this is so great as that involved in a reduction of the sense of light difference which cuts down the shadow effects.

The ultimate requirement in the perception of solid form is that the retinal stimuli must present a certain minimal amount of the characteristics of solidity to which the individual is accustomed, such as perspective, shadow effects, graded definition, and, in the case of those with two eyes, the two differing images. Where these stimuli are provided by photographs or other projection representations, it is necessary also that they do not contain inconsistences greater than will, in the particular circumstances, be overcome by the accommodative elasticity of whatever sense factors may be concerned.

## THE MONTGOMERY LECTURE. 1917-1918*

### A survey of cases of concomitant squint in the practice of the late Mr. P. W. Maxwell.

BY

EUPHAN M. MAXWELL, M.B.,

DUBLIN.

(*Concluded from page* 349.)

V. *Operative technique and results.*—Mr. Maxwell's operative technique may be thus briefly outlined:

(1) His tenotomies were always "complete," the tendon being severed as far forward as possible; the conjunctival wound was invariably sutured. The introduction of an "emergency suture" was a later development. This consisted of a double-threaded suture passed from behind forwards through the divided tendon and anterior lip of the conjunctival wound. It was left ready to tie over a bead, within a few hours to a few days after the operation, if an over effect was noted.

(2) His shortenings were performed with a "tucker" of his own design (Fig. 1).

Screw "a" regulates the height to which the control hook can raise the muscle. In the figure it stands about 8 mm. above the lateral hooks, in which position a shortening of 16 mm. could be accomplished.

Fig. 2 illustrates the tucker in position.

The double suture seen held in the forceps, was first passed through the posterior lip of the conjunctival wound, then through

*Delivered in the School of Physic, Trinity College, Dublin, on Friday, Nov. 8, 1918.

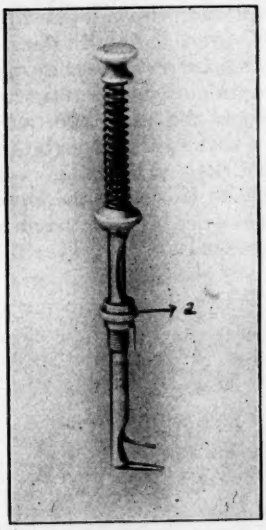


FIG. 1.

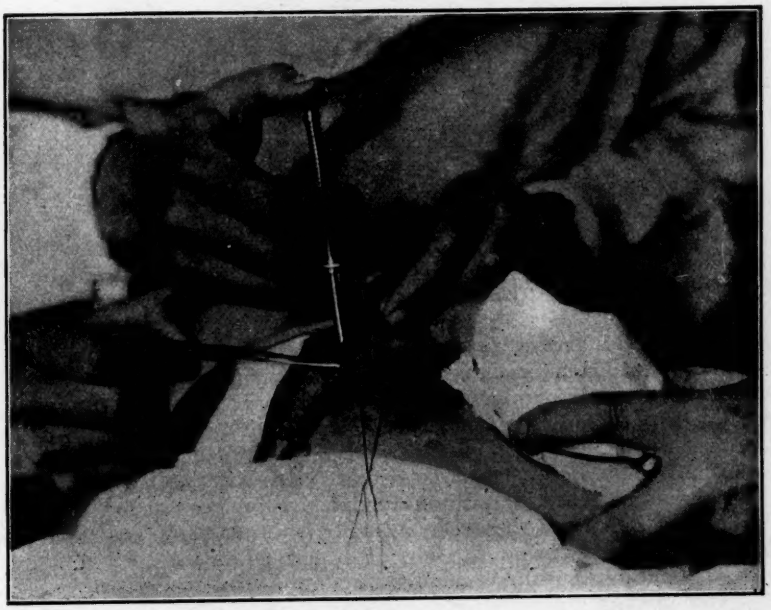

FIG. 2.

the muscle and finally through the anterior lip of the conjunctival wound where it was tied over beads. In this way the closure of the wound was effected without a second suture.

In the original description of the operation it was recommended to insert a suture through the upper portion of the muscle loop which could be brought backwards through the posterior lip of the conjunctival wound, and there tied. This procedure was intended to prevent any unsightly protrusion of the loop. As, however, such a protrusion, when it did exist, was very temporary, the procedure was abandoned as unnecessary.

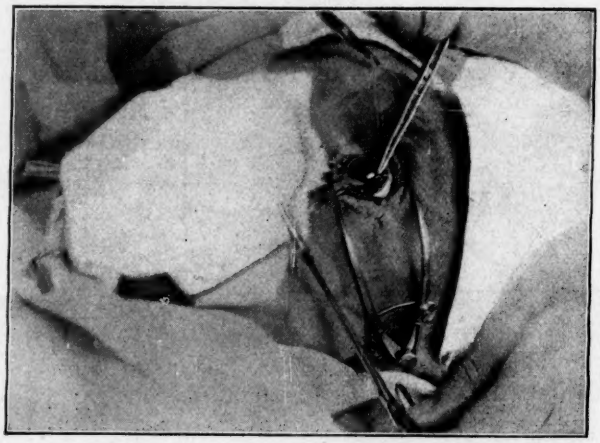

FIG. 3.

A slipping of the suture through the muscle fibres, thus lessening the intended size of the tuck, could only occur to a slight extent, as the tough connective tissue covering was as little disturbed as possible.

About 1911, anchor sutures were introduced. These were two double-threaded sutures passed through the superior and inferior recti respectively, and then, in the case of convergent squints, through the external canthus where they were tied together over rubber tubing.

Fig. 3 illustrates a "tucking" suture tied over beads, and two anchor sutures held away from the globe by forceps.

Fig. 4 illustrates these same anchor sutures tied over rubber tubing at their exit from the lid.

Anchor suturing in divergent squints met with but slight success. One method was recorded by which sutures through the superior

and inferior recti were secured with adhesive plaster to the nose; another by which a double threaded suture, introduced from without through the inner part of the upper lid, passed under the four recti muscles in succession to its exit through the inner part of the lower lid; the ends being then tied together over rubber tubing.

It is of interest to record that chemosis with the anchor sutures (not very infrequent with sterile vaseline) almost disappeared with the substitution of xeroform powder dressings.

In the shortening operations No. 3 curved needles for the muscle suture, and No. 3 half curved for the anchor sutures, were employed. The sutures were composed of No. 3 black and white silk respectively.

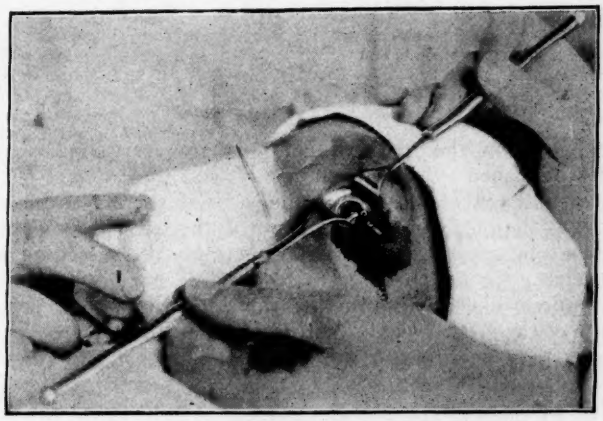

FIG. 4.

Where a shortening had been performed both eyes were bandaged for ten days to a fortnight. The anchor sutures were removed on the seventh day, the muscle sutures on the tenth. On the removal of the bandage, glasses, where indicated, were at once resumed. Their omission for a day or two, where operation was found to have over-corrected a convergence, was recorded as effecting the necessary change in several instances.

Most of the operations were performed under general anaesthesia. Changes in the deviation occurring as the result of the anaesthesia, were not allowed to interfere with the original plan.

The notes showed that for convergent squint the operation of tenotomy by itself lost in favour as time progressed, but as an adjunct to the shortening operation, was never abandoned.

The average results of *tenotomy* in ninety-four cases of *convergent squint* are here recorded:

The individual reductions were noted to vary considerably amongst themselves.

"Immediate reduction" implies the result as noted two to three days after the operation; "secondary" as noted about six months later. Only the reduction "longe" is recorded in this and the subsequent tables, the reduction "prox" being a still more variable quantity.

Where not otherwise notified the results in this and the subsequent tables were those recorded without glasses.

| General immediate *reduction* | With glasses | Operation on "fixing" *eye* | In angles over 30° | "Emergency" sutures inserted, but not tied |
|---|---|---|---|---|
| 16.5° | 14.5° | 18.75° | 19.5° | 15.5° |

| General secondary *reduction* |
|---|
| 19° |

The figures in the first two columns are very similar to the averages published by other authors.[4, 11]

The greater reduction noted in the cases of the larger angles was presumably the result of the cessation of the secondary adducting actions of the superior and inferior recti, on the lessening of the convergence.

No appreciable diminution in the reduction from the mere insertion of the "emergency" suture, was recorded.

The results, according to age, were as follows:

| | *Immediate reduction.* | Perfect cure. |
|---|---|---|
| Up to 14 years of age ... | 17.5° ... | 30 per cent. |
| *Over 14 years of age* ... | 15.0° ... | 40 per cent. |

The percentages of perfect cures were compiled from a survey of cases seen, one to several years after the tenotomy, no other operation having been performed in the interval. "Perfect cure" in this and the subsequent tables includes cases which, after operation became straight with glasses, but still showed some convergence without.

Out of six cases, seen some years later and noted as divergent, four had been operated on before puberty and two after.

3.5 per cent. of the cases were recorded as showing an upward deviation after the operation.

Two out of fifteen cases seen some years later were noted as having exophthalmos.

I was able to examine the mobility of the tenotomised muscle years after the operation in a few instances, and found an average

reduction in the rotation arc of about 6°. None of these cases complained of any discomfort in ordinary convergence.

A greater reduction was recorded in the few cases where a simultaneous double tenotomy was performed than in the cases where a short interval was allowed to elapse between the operations.

Only one partial tenotomy was noted; this caused no appreciable reduction in the squint.

The average results of ***single shortenings*** in 58 cases of ***convergent squint*** are here recorded:

Individual reductions were again noted to vary considerably amongst themselves.

"Immediate" reduction, wherever the result of a shortening is being recorded, implies the correction as noted two or three weeks after the operation: "secondary" as noted about six months later.

| General immediate reduction | | With glasses | | Operation on "fixing" eye | | "Anchor" sutures employed |
|---|---|---|---|---|---|---|
| 9.75° | ... | 4.75° | ... | 9.75° | ... | 13° |

| General secondary reduction |
|---|
| 9.75° |

The markedly lessened reduction noted in cases tested with glasses before and after the operation was presumably due to the fact that shortenings, single or double, were mainly performed in cases already much improved with glasses, a slight further improvement causing straightness. One or two cases where sepsis ensued, allowing of the sloughing away of the sutures, showed a temporary increase in the squint after operation; these were omitted from above list.

The results according to age were as follows:—

| | Immediate reduction. | | Perfect cures. |
|---|---|---|---|
| Up to 14 years of age | ... 8° | ... | 58 per cent. |
| Over 14 years of age | ... 12° | ... | 40 per cent. |

The percentages of "perfect cures" were compiled from a survey of cases seem one to several years after the shortening, no other operation having been performed in the interval.

The immediate results according to the number of mm. of shortening were:—

| 6-8mm. | ... | 9-11 mm. | ... | 12-14 mm. | ... | 15-18 mm. |
|---|---|---|---|---|---|---|
| 5° | ... | 9° | ... | 10° | ... | 15° |

These figures average roughly a reduction of 1° for every mm. of shortening; an average reduction of 2° for every mm. of shortening would appear to be the usual estimate of other observers [2, 3, 8, 9] This is suggestive of slipping of the sutures in the above cases, yet

all the same the general results effected by this "tucker" compare well with the general results of advancements and tendon tuckings as estimated by Jackson[4].

Two cases were noted as showing an upward displacement just after operation.

Two cases were recorded where a rupture of the muscle occurred during the operation. In one of them a shortening of 18 mm. was being attempted, in the other feeble development of the muscle was noted. These two instances represent about 0·4 per cent. of all the shortening operations performed.

I found an average increase in the rotation arc of about 5° in the few cases where I was able to examine the mobility of the shortened muscle, years after the operation.

The average results of *double shortenings* in 47 cases of *convergent squint* are here recorded :—

Individual results in these cases did not appear to differ so considerably amongst themselves.

| General immediate reduction. | With glasses. | Anchor sutures employed. | Restricted mobility outwards noted before operation | Double bandaging for over a week. |
|---|---|---|---|---|
| 21° | 10° | 21° | 26° | 25° |

| General secondary reduction. |
|---|
| 21° |

It will be noted that the average reduction in cases where anchor sutures were employed showed no increase over the general reduction as in the case of single shortenings. This may be due to the fact that the majority of these cases were performed with anchor sutures. It might also be the result of less movement on the part of the patient, both his external recti being painful.

The results according to age were :—

| | Immediate reduction. | Perfect cures. |
|---|---|---|
| Up to 14 years or age ... | 17.5° ... | 60 per cent. |
| Over 14 years of age ... | 25° ... | 35 per cent. |

The percentages of perfect cures were compiled from a survey of cases seen one to several years after the shortening, no other operation having been performed in the interval.

Three cases seen some months later and noted as divergent, were all operated on, after puberty.

The immediate results according to the number of mm. of shortening in each eye were :—

| 9-11 mm. | 12-14 mm. | 15-18 mm. |
|---|---|---|
| 10° | 21·5° | 28° |

One case was noted as showing a downward displacement just after operation.

The average reduction effected by double shortenings in cases where a brief interval was allowed to elapse between the operations was 16·5°, as compared with the average 21° effected in the case of simultaneous double shortenings.

The average results of *tenotomy* combined with *shortening* in 52 cases of *convergent squint* are here recorded.

Individual results in these cases showed remarkable constancy.

| General immediate reduction. | With glasses. | "Emergency" sutures inserted but not tied. |
|---|---|---|
| 26·5° | 25° | 29° |

| General secondary reduction. |
|---|
| 27° |

The results according to age were as follows:

| | Immediate reduction. |
|---|---|
| Up to 14 years of age ... ... ... | 26° |
| Over 14 years of age ... ... ... | 26° |

No difference in the relative number of perfect cures or divergences was noted in respect to age.

The immediate results according to the number of mm. of shortening were:

| 6-8 mm. | 9-11 mm. | 12.14 mm. |
|---|---|---|
| 21° | 24° | 30° |

Five cases were noted as showing altitudinal displacements just after operation.

Two out of twenty cases seen years after operation were recorded as having developed an exophthalmos.

One case was noted in which a mild tenonitis developed in the shortened muscle, just after operation.

In the few instances where mobility was examined, an average reduction inwards in the rotation arc of about 8° and increase outwards of about 6° was found.

The average reduction effected, where a brief interval was allowed to elapse between the tenotomy and the shortening was 20·5°, as compared with the average 26° effected in the case where the operations were combined.

The following tables show some interesting points in connection with those *convergent squints* which became *divergent* after operation. Cases which showed divergence with glasses after operation, but were straight or still convergent without, were omitted from the percentages.

| Divergence following tenotomy. | Tenotomy and shortening. | Double shortening. | Single shortening. |
|---|---|---|---|
| 40 per cent. | 25 per cent. | 35 per cent. | 0 per cent. |

Two of the cases which diverged after shortening had restricted outward mobility noted before operation.

| Squint amblyopia present. | Bad fixation. | Sense of perspective. | Temporary diplopia developing after operation. |
|---|---|---|---|
| 55 per cent. | 20 per cent. | 0 per cent. | 25 per cent. |

The majority of these cases did not diverge immediately after operation but on an average about $2\frac{1}{2}$ years later.

These "late" secondary divergences occurred, according to the age at which the operation was performed, as here shown :—

| Operated on— Under 6 years of age. | 6-14 years of age. | Over 14 years of age. |
|---|---|---|
| 40 per cent. | 60 per cent. | 0 per cent. |

All the cases of "late" secondary divergence noted, occurred after tenotomy or tenotomy and shortening.

The average results of *tenotomy* in sixteen cases of *divergent concomitant squint* are here recorded :

| General immediate reduction, | General secondary reduction. |
|---|---|
| 16·5° | 7·5° |

Both the immediate and secondary reductions were greater in the cases associated with divergence excess, than in those associated with convergence insufficiency.

The immediate reduction according to age showed :

| | |
|---|---|
| Up to 14 years of age ... ... ... | 16° |
| Over 14 years of age ... ... ... | 17° |

One case of downward squint occurring after operation was noted.

The cases of *divergence* treated by means of *shortening* operations were not sufficiently well recorded for tabulation. Two or three instances of a latent divergence associated with convergence insufficiency cured by this operation, were noted. In three cases of divergence following tenotomy for convergence, the average immediate reduction effected by a single shortening was 4°.

The average results of *tenotomy and shortening* in 26 cases of *divergent squint* are here recorded :

| General immediate reduction. | General secondary reduction. |
|---|---|
| 25° | 18°. |

This average secondary reduction corresponds with Jackson's estimate.[4]

The immediate reduction was greater in the cases associated with convergence insufficiency, than in those associated with divergence excess.

The immediate reduction according to age was:

| | |
|---|---|
| Up to 14 years of age... ... ... | 27·0° |
| Over 14 years of age ... ... ... | 23·5° |

The immediate results according to the numbers of mm. of shortening were :—

5-12 mm., 23·5° ; 14 mm., 26·5°.

Two cases of upward, and one of downward squint, occurring after operation, were noted.

In three cases, where the mobility was tested, years after the operation, an average decrease of roughly 15° in outward rotation was noted, the internal rotation arc being about 44° in both eyes, in these instances.

The cases in which an interval was allowed to elapse between the operations showed an average reduction of 17·5° as compared with the average 25° effected by a simultaneous tenotomy and shortening.

Three cases of *convergence* were noted following operation for *divergence*. The cases were all associated with convergence insufficiency, were myopic, had good fixation, and corrected vision. They were all noted as developing a temporary homonymous diplopia after operation. The operation in one case was a tenotomy, in the other two tenotomy combined with shortening.

As regards the results of operations on the *vertical muscles* only two cases were satisfactorily recorded :

(1) An upward squint of 20°, reduced to 5° by a tenotomy of the internal rectus, was corrected vertically by a tenotomy of the superior rectus.

(2) An upward squint of 10°, accompanied by slight convergence, was corrected vertically by a tenotomy of the superior rectus. A slight divergence, and a widening of the palpebral fissure on the inner side, was noted after the operation.

These results roughly correspond with Landolt's estimate of the average reduction effected by tenotomy of the superior rectus.[5]

My own experience of the treatment of squint is too limited to allow of an opinion based on personal results; certain points, however, emphasised themselves in my mind during the preparation of this paper, which are here enumerated.

I.—*Early operation and fusion training in concomitant convergent squint* :

That, as the best training for the eye is to put it straight, early operation in convergent squint is strongly indicated. The correction before operation, of any deviation from the normal, such as enlarged tonsils and adenoids, should not be forgotten. In the very young, between two and four years, an improvement with glasses and occlusion of the fixing eye may be expected to continue up to within one and a half years after the commencement of treatment ; in older patients no very marked further improvement after three months would appear to take place.

Fusion training in the very young appeals to me in theory, but it

would seem to necessitate qualities on the part of the ophthalmic surgeon more difficult to acquire than operative dexterity. Rather do post-operative orthoptic measures, at a time when the child can co-operate, commend themselves to my mind. Where suppression can be artificially overcome, these would appear to be of value up to puberty or later.

As so few squinters would appear ultimately to attain binocular vision, its practical importance in everyday life becomes, in discussing this subject, a matter of interest.

I venture to think that as few forms of work are impossible without it, its value may be greatly over-estimated by those who especially interest themselves in its development.

II.—*The choice of operation in concomitant convergent squint*:

That the choice of operation in c.c. squint must be determined by the age of the patient, as well as by the size of his angle. During the period of rapid growth, say up to twelve years of age, when the possibility of the development of a secondary divergence is greatest, only advancements or shortenings would appear to be indicated. After this age tenotomy is surely a most valuable method of treatment. As the retraction of the capsule of Tenon, which may follow this operation is thought by some observers to be a more potent factor in the development of a subsequent exophthalmos than the division of the muscle, might not its inclusion in the conjunctival suture lesson the occurrence of this disfigurement ?

III.— *The classification and treatment of concomitant divergent squint:*

That the two main types of concomitant divergent squint, with their essential treatments, are :—

(1) Squints the result of "convergence insufficiency."

This condition is apparently most often associated with bilateral myopia and, in such cases, would be a consequence of the poor development of the function of convergence.

Where operation is indicated, a shortening or advancing, would appear to offer the best chance of success.

(2) Squints, the result of "divergence excess."

This condition is apparently most often associated with emmetropia or low degrees of hypermetropia. The refractive error obviously plays no part in the causation.

The excess in divergence may conceivably, in many instances be the result of an instability of the convergence centre. The "neuropathic divergent squints" described by Worth seem to me to correspond in the main with the cases of "divergence excess" described by Wooton.[10,11]

Attention to the general health, combined with convergence exercises, would appear to be the treatment indicated. Where operation is necessary, tenotomy seems to offer the best chance of success. The external rectus being less liable to retraction than the internal, and full external mobility being of less importance than internal, it can be performed at an early age with less risk than in the case of convergence.

IV.—*An estimation of the result of operation for concomitant squint*:

That as the results of any individual operation cannot be mathematically estimated beforehand, the exact size of the angle is of less importance than a knowledge of the fixation and vision of the eye, together with existing muscular anomalies or complicating factors. A knowledge of the existence of diplopia beforehand may be of some help in an estimation of the value of post-operative orthoptic exercises, its temporary development after operation is apparently of no prognostic value.

At the same time, despite individual differences in operations, it is noteworthy how closely the various averages tally. Some scheme, therefore, of measurement would appear to be of value even to the most experienced of operators.

In young children with c.c. squint, straightness with glasses would appear to be the ideal result. In older persons complete corrections of squint without glasses may be attempted.

V.—*Shortening versus advancement*:

That, in an estimation of the respective merits of the shortening or tucking as compared with the advancing operations, the following points would appear to be in favour of the former:

(1) Great ease in the performance of the operation.

(2) Rarity in the accidental production of altitudinal displacements.

(3) The impossibility of a slip backwards on the part of the tendon.

(4) The almost negligible interference with the health of the muscle.

(5) The great ease with which a reshortening can be performed.

Against this method is the fact that on an average less reduction is effected than by advancement.

On the average estimation that an advancement of 1 mm. will effect a reduction of 2°, the greatest result that may be expected without resection in cc. squint is 15°, as the insertion of the external rectus is normally 6·7 mm. from the cornea.[4] We may take, therefore, a reduction of 12° to 15° as the average effect of a single advancement in cc. squint, as compared with a reduction of 9°-12°, the average effect of a single shortening.

A similar relative comparison can presumably be made when dealing with the internal rectus in divergence.

If the muscle insertion is unusually far back an advancement may be expected to produce a still greater effect. In such cases, therefore, if a big reduction be necessary, I would suggest that advancement be the operation of choice. Again, where at the time of operation the muscle is found to be very poorly developed, an advancement would appear to offer a better chance of success.

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## ANNOTATIONS

### The Qualifications of Ophthalmic Surgeons

In the columns of this Journal (March, 1918) we published an appeal that some degree or diploma should be open to ophthalmic surgeons commensurate with the position occupied by them in the medical profession. We then suggested that it would be useful in bridging the hiatus if ophthalmology were in part substituted for the final examination for the M.S. (Lond.) and the F.R.C.S. (Eng.). This would have far-reaching consequences, into which we need not enter at the moment. It is with satisfaction that we now learn that the Senate of London University has sanctioned the granting of the M.S. degree in two additional branches, one of which is ophthalmology. The regulations have been modified in accordance with the foregoing decision.

### The Need of a New Eye Hospital in Calcutta

In our issue of May, 1919, we commented at some length on the apathy which has been displayed by the Government of Bengal

toward the question of the provision of a new Eye Hospital for Calcutta, and we expressed the hope that the matter would be taken in hand at an early date. It is, therefore, with some satisfaction that we have perused the columns of the *Statesman's* issue of June 21 last. A very prominent place is given to a long leader on the subject, in which our article is extensively quoted and warmly welcomed. On the same page the text of the annotation is quoted *verbatim*. It is to be remembered that the *Statesman* is the leading paper of Calcutta, the second largest city in the British Empire. India owes a very great debt to its ophthalmic surgeons, the great majority of whom have been officers of the State Medical Service, but that indebtedness has been very scantily acknowledged. No better illustration of this could be furnished than the fact that so able, zealous, and distinguished an officer as Colonel Maynard should have spent the best years of his life in the endeavour to get his Government to build an Eye Hospital suitable for the needs of the great Presidency he has served, only to see his work come to fruition when he himself has finished his labours in the land for which he spent his toil. We learn that money has been allotted for the site and for the building; but the question we would like to thrust home is this: Will suitable provision be made to staff and equip this institution in the right manner? The Indian student is backward; his initial standards are low; however high he is lifted, his tendency is to fall away to a lower plane as soon as he finds himself left to himself. General Booth used to say that if you aimed at the moon, you were likely to hit something higher than a gooseberry bush. This is an axiom that the teacher in any University, and especially an Indian one, should always keep steadily before him. The Professor in an Eastern University cannot aim too high himself, nor can he be too persistent in pressing the loftiest of ideals on the daily notice of his students. The opportunities for ophthalmic work in India are so immense as to demand that the very best possible men shall be selected for such posts as the superintendentship of the big hospitals in Calcutta, Madras, Bombay, and Lucknow. Once the selection is made, money should be lavishly provided, and every encouragement should be given to all concerned, from the Superintendent downward, to turn out the best possible work. In the past, and we fear even at the present time, a man with large ideas is condemned as a nuisance. Men who have risen in the Civil Service to high administrative appointments as a result of having "kept in" with the powers that be, but who have no other qualifications for the execution of their office, only too often control the schemes of the earnest scientific worker. It is one of the weakest points of Indian administration, that in the Civil Service the best men so often fail to reach the top; their ideas are too

upsetting; they are considered a nuisance, and are therefore eliminated. The result is that the power too often lies in the hands of men whose petty parochial ideas are concerned only with the saving of money to Government, and with the increase of their own kudos thereby. India's great need, from a medical point of view, is rule by men with large and statesmanlike views on all questions connected with scientific medicine. To place a man of science in a position of large opportunity, and then to crush the soul out of him by thwarting his big schemes at every turn, is an act of hostility to the interests of the country he is striving to serve. We hope that the Bengal Government will lay this to heart, that the new hospital will be dealt with in no niggardly fashion, and that all who work for it will be encouraged to bring to their labours the best that is in them. This can only be possible if the treatment they meet with is both generous and sympathetic. Nor would we confine ourselves to speaking of Calcutta alone. The Government of India and the local Governments, one and all, have in the past failed most miserably to realize their responsibility to the vast hordes of blind people within their territories. There is a crying need for a wider view of their duties, and for a fulfilment of the obligations which press upon them. We welcome the action the *Statesman* has taken, and we know enough of the Indian Press to feel confident that this example will be followed; indeed, we are already assured that the leading medical journal of India, the *Indian Medical Gazette*, has turned its attention to the subject. We trust that both the lay and scientific press will keep up the campaign until something really large and worth doing has been done. Once again, we commend the matter very earnestly to the notice, not only of the Governments, but also of every one who is really interested in the welfare of our Indian Empire.

## BOOK NOTICES

### *Scientific Communications (Communicaciones cientificas.)*

By DR. MENACHO, Barcelona, 1917.

The author of this little pamphlet groups together certain papers which have appeared in 1916-1917 in the *Archivos de Oftal. Hisp.-Americ.*, and other Spanish periodicals. The papers are eight in number, and deal with the following subjects:—

1. Congenital pigmentation of the optic nerve.
2. Glaucoma consequent on needling of a secondary cataract.

3. Opaque nerve fibres, with a report of an unusually marked case of this condition.
4. Spontaneous absorption of cataract.
5. Some congenital vascular anomalies of the fundus oculi.
6. Associated movements of the upper lid during mastication.
7. Antonio de Gimbernat, surgeon, considered as an oculist.
8. Obituary notice of Dr. Julian Masselon.

The various vascular anomalies discussed are illustrated by rather crude drawings. The paper on Gimbernat was read on November 17, 1916, the centenary of his death. It will possibly be news to many of us that Gimbernat practised ophthalmology, his name is so much more familiar to us in connection with another part of the body than the eye; but Menacho proves from his works that he was an authority on the anatomy of the cornea, and on the diagnosis and treatment of corneal ulcers, and also that he frequently operated for cataract with successful results. Gimbernat was born in Cambrils, Tarragona, Feb. 15, 1734, and died in Madrid, Nov. 17, 1816. He was the organizer, under the patronage of King Carlos III, of the College of Surgery of San Carlos in Madrid. The last paper is an appreciation of Masselon, who was de Wecker's *chef de clinique* in Paris for many years, and under whom the author worked.

R. R. JAMES.

**Hygiene of the Eye.** By WM. CAMPBELL POSEY, A.B., M.D., Philadelphia. Pp. 344 with 120 illustrations. London and Philadelphia, J. B. Lippincott Company, 1918.

This book deals with a subject the importance of which it would be difficult to overestimate. The loss of efficiency, looked at from the lowest commercial standpoint, that results from preventible defects of vision amounts to a terrible total. Posey's book is a praiseworthy attempt to put some of the problems involved on a clear basis. The difficulty of deciding quite what audience it is addressed to has resulted in a rather unfortunate compromise. Thus, the portion that deals with the anatomy and physiology and diseases of the eye is too elementary for the ophthalmologist, and yet not sufficiently so to be of use to the general public. Space is also wasted on ocular disease of the nature and prevention of which we have no sure knowledge. The author contributes chapters on school life and on contagious eye diseases of a most useful description. Herbert E. Ives contributes a valuable chapter on artificial illumination, and daylight illumination is adequately dealt with by a practical architect, W. C. Farber. A very good account is given of various types of industrial accident both as regards treatment and prevention. This chapter is well illustrated. O. H. Burritt,

M.A., is the author of the chapter on blindness and education of the blind, for the writing of which his experience as Principal of the Pennsylvania Institution for the Instruction of the Blind renders him well qualified.

In a later edition, which we are confident will be required, Posey would do well to eliminate some of the work which is not directly concerned with the title, and further elaborate some of the more important chapters.

E. E. H.

**The Refraction of the Eye : a manual for students.** By GUSTAVUS HARTRIDGE. Sixteenth edition. London : J. & A. Churchill, 7, Great Marlborough Street. 1919. Price 7/6 net.

The sixteenth edition of a popular handbook calls for no praise from us. The reasons for its popularity are not far to seek—its clear statements and explanations of a difficult subject, its abundance of illustrations, the almost complete absence of algebraic formulae, and the moderate price at which it is sold. Additional points introduced into this edition include an account of new kinds of glass used in the construction of spectacles, and the visual requirements for commissions of the Royal Air Force. It is interesting to note at this juncture that Hartridge deplores the fact that the English railways have no uniform standard for sight.

S. S.

**The Ophthalmoscope: a manual for students.** By GUSTAVUS HARTRIDGE. Sixth edition. London: J. & A. Churchill, 7, Great Marlborough Street. 1919. Price 6/6 net.

This useful introduction to ophthalmoscopy has reached its sixth edition and thoroughly deserves its success. It is likely to be of service to all who are learning to use the ophthalmoscope, which at the present day is almost as useful to the general practitioner as to the ophthalmic surgeon. While the coloured plates are excellent, although printed upon rather thin paper, many of the woodcuts of fundus conditions leave something to be desired, but this is doubtless to be accounted for by the low price at which the volume is produced. We failed to find any account of the electric ophthalmoscope on reading the book.

S. S.

**Transactions of the American Ophthalmological Society.** Volume XVI. Philadelphia. 1918.

A substantial volume of 412 pages embodies the proceedings of the Fifty-Fourth Annual Meeting of the American Ophthalmological Society held on July 9, 1918, at New London, Conn. It is illustrated and provided with an index. It includes an account of

members who have died since the last *Transactions* made its appearance—Drs. Charles H. Williams, of Boston, and F. M. Wilson, of Bridgeport. It was agreed that the dues of any member engaged in Government service should be remitted upon request during the period of such service. The scientific contents of the volume will be noticed in our columns in abstract, but in the present place it would be invidious among so much that is good to select any one for special mention. The officers and council elected at the meeting included: *President*, Lucien Howe, Buffalo; *Vice-President*, Hiram Woods, Baltimore; *Secretary-Treasurer*, T. B. Holloway, Philadelphia; *Council*, Arnold Knapp, New York; William Zentmayer, Philadelphia; C. F. Clark, Columbus; Cassius D. Westcott, Chicago; and W. B. Lancaster, Boston. S. S.

**Ophthalmological Society of Egypt.** Bulletin of 1918. Cairo: Printed by Paul Barbey, 18, Abdel-Aziz Street.

This paper-backed volume of 187 pages contains the proceedings of the Egyptian Ophthalmological Society of Egypt held on March 1, 1918, in the Pathological Museum of Kasr El Ainy Medical School, under the presidency of Dr. E. V. Oulton. It is printed in English. S. S.

**Bulletin de la Société Belge d'Ophtalmologie, No. 39. Compte rendu analytique de la 39e réunion de la Société, à Bruxelles, le 29 juin, 1919.** Gand: Maison d'editions et d'impressions, Anct. Ad. Hoste, S. A. 21-23, Rue du Calvaire. 1919.

The present *Bulletin* of the Belgian Society of Ophthalmology is the first issued since the outbreak of war. It represents the proceedings of the Society when it met at Brussels on June 29, 1919, and contains no scientific matter, properly so-called. It contains an address of the Secretary-General of the Society, Dr. van Duyse, from which we gather that it is proposed to remove from the roll the names of certain members, honorary, associated, or effective, who are associated with enemy alien countries. A handsome tribute is paid to Drs. De Mets and Ridder, whose wives shared in the patriotic and humanitarian work accomplished by these devoted men. Dr. van Duyse also delivered a message of congratulation to Professor J. B. Coppez on his jubilee. Professor Coppez made a suitable reply. The small volume ends with an account of members who have joined the great majority, namely, Homère Callaert, of Antwerp; Edouard Pergens of Maeseyck; Rafael van Oye of Ostend; Frans Lacompte of Ghent; and Auguste Philippe van Schevensteen, of Antwerp. S. S.

**Transactions of the Twenty-second and Twenty-third Annual Meetings of the American Academy of Ophthalmology and Oto-Laryngology.**

The large size of this volume (614 pages) is accounted for by the fact that it includes the papers read at Pittsburg in 1917, and at Denver in 1918. 344 pages of its contents are devoted to subjects dealing with the eye. From a report for the American Board for Ophthalmic Examinations (p. 213), we gather that candidates for examination are reqùired to sign the following: "I hereby pledge myself not to accept commissions from any optician for work sent to such optician, nor to divide fees, nor to pay commissions to any persons referring cases to me." Failure to observe this condition, upon which the certificates are granted, is an essential fraud, justifying revocation of the certificate. The book also includes a report of a commission on the aetiology of iritis, the outcome of a communication by the late Wendell Reber. The commission consisted of Drs. Reber (as chairman), W. B. Lancaster and John Green, jnr. After the loss of the chairman, Dr. Walter R. Parker was elected a member. The report, however, is still incomplete, the members having limited themselves to presenting a résumé of the more important papers that have appeared upon the subject during 1917. In this list are included cases by two English writers, namely, William Lang and Leslie Paton.

S. S.

## CORRESPONDENCE

### TONOMETRIC VALUES

*To the Editor of* THE BRITISH JOURNAL OF OPHTHALMOLOGY

SIR,—As I wrote the original review in your columns (April, 1919) on McLean's paper on Tonometry, and as I have since had the privilege of discussing the matter very fully with McLean himself, I shall be obliged if you will allow me to offer some observations on Priestley Smith's paper "On Tonometric Values" which appeared in your July issue.

Priestley Smith states that it "has been proved by experiment that eyes giving the same tonometric readings may have different internal pressures, and that eyes giving different readings may have the same internal pressure." He then makes reference to his experiments in which he compared the manometer and tonometer readings in a fresh pig's eye, in the same eye after three and a half

hours in formalin solution (5 per cent.), and again after twenty-three hours in the same solution. He adds "the formalin, of course, stiffened the tissues, diminished the impressibility of the eye, and falsified the mercury equivalents given by the Schiötz curve." As a proof of his point, I submit that these experiments are without any value. That formalin solution would make the coat of the eye rigid, and therefore make tonometer readings, valueless, is obvious, but has this any bearing on the relation between manometer and tonometer readings on the living eye? I think not. As McLean said at Oxford, if you wish to make relative manometer and tonometer readings which shall be of any value, you must make them on the living eye *in situ*, or at least on eyes as soon as possible after removal. McLean has made several hundred such observations and has failed to find the comparatively large differences which Priestley Smith thinks exist as a consequence of the element introduced into the case by the variations in the thickness, elasticity, etc., of the tunic of the eye. McLean's observations are positive, that, under normal conditions of experiment, the variations, which Priestley Smith expected, do not exist. I submit that this position could only be upset by a series of control experiments on living or at least on fresh eyes. Should considerable differences then be found to exist, it would be open to the observer to section the eyes, to compare the thickness and the other characteristics of the coats and so to reach a logical adverse conclusion. After studying McLean's work, it may be questioned whether there is the least likelihood of his conclusion being upset in such a way.

Priestley Smith goes on to say, "Many suppose that a first-class instrument should measure the pressure in the eye as accurately as a thermometer measures the temperature of the blood." But, a thermometer does *not* measure the temperature of the blood accurately, at least under clinical conditions. Severe and well recognized physical limitations to its accuracy exist in all skin readings, and what is more, these vary with different people. The readings in the mouth come nearer to accuracy, and those in the rectum nearer still, but a margin of error—even though a slight one—still exists. It must continue to do so, for we are never likely to introduce an instrument into the blood-stream, just as we may not introduce one into the interior of the eye. On the other hand, McLean has shown how near to accuracy a good tonometer, like a good thermometer, may come.

Those who think that this is a matter of little interest can very little appreciate the real importance of the question. If Priestley Smith is right in believing that the variations in the tunics of the human eye are such as to preclude the hope that we may be able to make rapid, direct, and reliable readings with the tonometer, the prospect of this instrument becoming much more

widely used is a poor one. On the other hand, if McLean is correct in his contention, that readings made by his tonometer *are* correct to within a few mm. of Hg. he has placed in our hands a clinical instrument of extraordinary value, has widened the horizon of Professor Schiötz's epoch-making work, and has deserved the gratitude of the ever-increasing number of those who rely on scientific tonometry.

Priestley Smith discusses at length the discrepancies between the Schiötz and the McLean readings, and suggests that possibly McLean failed to shut off the manometer before taking his tonometer readings. McLean effectually disposed of this suggestion in his valuable paper at Oxford. We must, therefore, look elsewhere for the true explanation. In so doing, two important points present themselves: (1) McLean's technique is extraordinarily careful. He has made use of the work of previous observers, and has added precision to it from the rich store of his own mechanical knowledge. How many ophthalmologists could make, with their own hands, such mechanically perfect apparatus as was recently demonstrated at Oxford? How many of us could turn out as a finished article the beautiful McLean tonometer? McLean has done both, and without any aid from a workman. The precision with which he has placed his valve the right distance back in the canula, the simple but beautiful means he demonstrated for preventing leakage alongside of that canula, the care and thought which have presided over every detail of his work, all of these claim our confidence and respect for the conclusions which he has drawn. (2) When I was discussing the matter with McLean, he told me that he had been very careful always to keep the cornea wet with normal saline solution during his experiments, and he raised the question as to whether the discrepancy between his results and those of Priestley Smith and Schiötz might not be due to the others having failed in this precaution. On his return to America he proposes at once to make a number of observations to test this point, and has promised to communicate the results to me without delay. Be it clearly understood that I do not affirm that these observers did fail to moisten the corneae before each and every reading. I merely offer the explanation which occurred to us in conversation as a possible one. The question can easily be set at rest.

In conclusion, I desire to say most emphatically that the object of this letter is in no way to take sides with McLean against Priestley Smith. No one admires more sincerely than I do the great work which Priestley Smith has done and the scientific spirit in which he has done it. Every English ophthalmologist looks up to him as to an honoured teacher. The very fact that any opinion emanating from such a source is bound to carry the

greatest weight with all who read it, has made me feel the importance of entering a note of dissent in a matter which I, for one, believe to be of great clinical importance. If I have in any way misunderstood, or quite unwillingly and unintentionally misrepresented Priestley Smith's views, I trust that he will at once correct me, and I shall tender my amplest apologies.

The question, as I understand it, is: Have we in the McLean tonometer an accurate instrument whereby we can measure the intraocular pressure with the same accuracy as we estimate body temperature with the clinical thermometer? I have been using this instrument side by side with my trusted Schiötz tonometer for some weeks past, and I think we have. The only outstanding question to my mind lies in the explanation we are going to accept as to the difference between McLean's pressures and those of Schiötz and Smith. Be it remembered that McLean is offering no new estimate of the normal intraocular pressure, but is rather going back to the older estimates which we accepted before our ideas were upset by the advent of the valuable Schiötz instrument.

Yours, etc.,

R. H. ELLIOT,

LONDON, W., *July* 19, 1919. Lt.-Col. I.M.S. (Ret.)

## PEDUNCULATED HAEMANGEIOMA OF CONJUNCTIVA

*To the Editor*, BRITISH JOURNAL OF OPHTHALMOLOGY.

SIR,—On looking through back numbers of the BRITISH JOURNAL OF OPHTHALMOLOGY, published during my absence abroad, I notice in the Journal for March, 1918, a paper by Messrs. Rutson James and R. S. Trevor, on haemangeioma of the palpebral conjunctiva. They describe two cases of this condition in which the growth formed a pedicled tumour, both of them occurring in youths. They state that references to such tumours in ophthalmic literature are very few, and they were only able to find references to some six other cases, four of which are taken from foreign literature. It may interest, therefore, the authors of this paper to learn a few details of a case that occurred five years ago in my practice in Norwich, especially as the patient was a man aged about 55 years, for all the previously recorded cases in this country were youths of 20 years or under.

The only symptom my patient had was that of occasional slight "bleeding from the lid" for about three months before consulting me; in this respect it differs from the authors' two cases, one of

which complained of a lump on the lid, and the other of defective sight, but neither of them had any haemorrhage from the tumour.

On everting this patient's left upper lid, a small pedicled tumour the size of a pea was at once seen, growing from the surface of the palpebral conjunctiva, mid-way between the upper fornix and the lid margin and slightly towards the nasal side; the tumour looked vascular and semi-transparent, was flattened from before backwards and was freely movable on its pedicle: there was no general conjunctival hyperaemia, nor any excessive lacrymation.

The tumour was snipped off with scissors and its base cauterized with silver nitrate stick. Dr. Claridge kindly cut a section of the tumour for me and reported as follows: "It consists of a collection of capillaries with a very small amount of connective tissue, and is evidently a capillary angeioma or naevus."

On looking at the slide after reading Messrs. James and Trevor's communication on the subject, one can see with the naked eye that it is a pedunculated tumour enclosed in a capsule; its appearance is remarkably similar to the illustration of the section appearing in the paper in question, except that I do not see any pigment in any part of the slide. If the surviving author of the communication above referred to would care to see the section, I shall be pleased to send it to him.

Yours, etc.,

NORWICH, *July* 9, 1919. G. MAXTED.

## MYOPIA

*To the Editor*, BRITISH JOURNAL OF OPHTHALMOLOGY.

SIR,—Dr. Thomson's paper in your July issue recalls some work* I did on this subject years ago. He deals with children only, and while his numbers are small it is interesting to observe that he breaks away from the blind continuity of text-book tradition.

Anyone interested should study the laws of heredity, for myopia exhibits an interesting sex limitation, but this can only be brought out when large numbers are dealt with.

Yours, etc.,

J. A. WILSON.

THE LORD DERBY WAR HOSPITAL, WARRINGTON.
*July* 5, 1919.

*"The Factor of Heredity in Myopia," *British Medical Journal*, August 29, 1914.

# NOTES

**Appointments**

MAJOR A. E. J. LISTER, ophthalmic surgeon to King George's Medical College, Lucknow, has been appointed an honorary surgeon to His Excellency the Viceroy and Governor-General of India. We understand that this is the first occasion upon which an ophthalmologist has been made an honorary surgeon to the Viceroy.

Mr. N. Bishop Harman has been appointed ophthalmic surgeon to the National Institute for the Blind. Mr. F. A. Juler has been appointed ophthalmic surgeon to the London Lock Hospital. Mr. James McHoul has been appointed ophthalmic surgeon to the French Hospital in London. Mr. W. L. Hines has been appointed ophthalmic surgeon to the Miller General Hospital, Greenwich. Mr. Sydney Tibbles has been appointed ophthalmic surgeon to the Western General Dispensary. Mr. James A. Craig has been appointed lecturer on ophthalmology, and Mr. Haydn Mulholland clinical lecturer on ophthalmology at the Queen's University, Belfast. Mr. H. V. White has been appointed ophthalmic surgeon to the Salford Royal Hospital. Mr. Harry Lee has been appointed ophthalmic surgeon to the Leeds General Infirmary.

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**The Blind**

IN the Parliamentary papers of July 3 last Mr. Macpherson stated that Parliament would soon be invited to make provision of approximately £125,000 for England and Scotland for assistance to the blind.

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**Amalgamation rejected at Portsmouth**

THE Portsmouth Eye and Ear Hospital has rejected the proposal made for amalgamation by the Royal Hospital. The chairman of the former institution is reported to have said that investigation by himself and his colleagues showed that the Royal could give the Eye Hospital no additional accommodation, while if the Royal came to the Eye Hospital at least four wards and a new theatre would be required. Unlike the Royal the Eye Hospital was a county institution, and he feared that amalgamation would mean loss of subscriptions.

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**A Charlatan Fined**

IT is satisfactory to note that a person named Mathew Digby Wyatt, who practised with his wife and son as "Sir M. D. Wyatt, Lady Wyatt and Son, eye specialists," at Windsor, Australia, has been

fined £25 and costs as a rogue and vagabond at the Praham Court. It appears that a labouring man, who had been blind for twelve months, consulted Wyatt, and undertook to sell his house and to give him £200 if he could restore his sight. Wyatt required £4 4s. before beginning the cure, and that sum was paid in two instalments. A lotion for "cataract" was given, but that treatment led to no improvement in the patient's sight, the failure of which was due to optic atrophy. The chairman of the Bench stated that had it not been for Wyatt's age, 72 years, he would have been imprisoned without the option of a fine. Wyatt was ordered to refund the £4 4s. paid by the aggrieved man.

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**Diploma in Ophthalmology**

AT the examination for the diploma in ophthalmology of the University of Oxford, held in July last, the following gentlemen succeeded in satisfying the examiners: H. W. Archer-Hall, E. M. Eaton, V. O'Hea Cassen, W. H. Kiep, and W. C. Souter.

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**Ophthalmic Periodicals**

IT is with satisfaction that we learn that the publication of the *Revue Générale d'Ophtalmologie*, suspended since the outbreak of war, is to be undertaken immediately. The head quarters are to be shifted from Lyons to Geneva, and in future the journal is to edited by Dr. D. Gourfein.

The Bulletin of the Belgian Society of Ophthalmology is to re-appear twice a year. The first issue is noticed in our present number.

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**A new Ophthalmological Society.**

THE ophthalmologists of Bucharest have founded an ophthalmological society in that city. The following are the officers: *President*, Professor Constantinesco; *Treasurer*, Dr. Rasvan; *Secretary*, Dr. Ghica. The Society meets twice a month at the Coltzau Hospital, and publishes its *Transactions* twice a year.